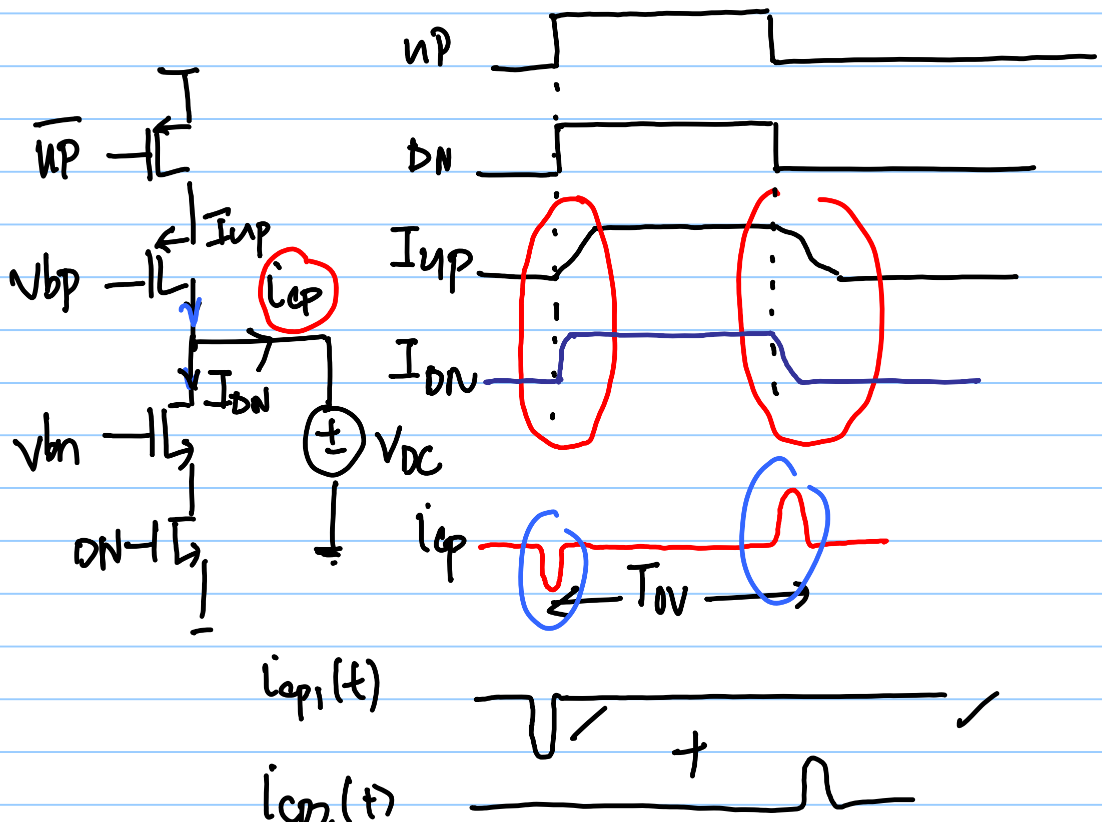
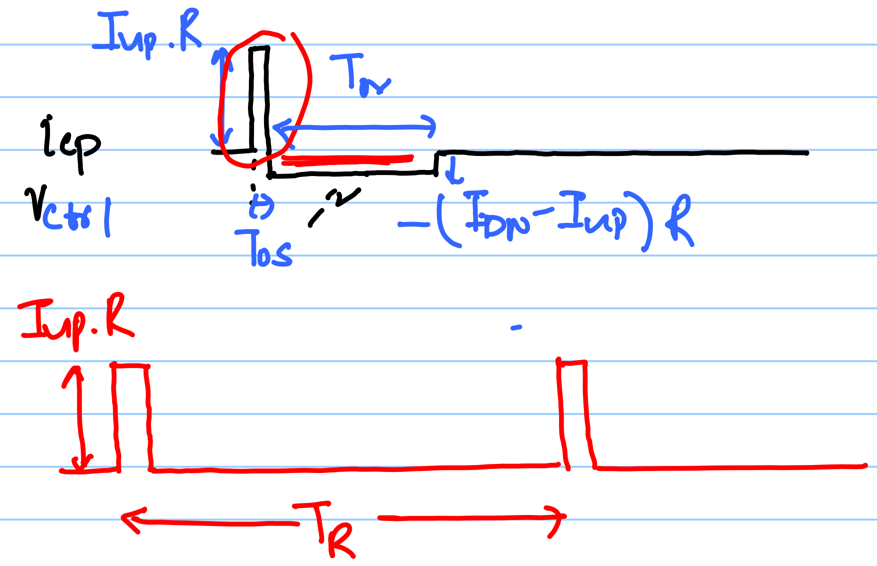
lecture #37

Charge-pump



$= i_{cp1}(t - T_{ov})$



$$V_{ctrl} = a_0 + \sum a_n \cos(n\omega_R t) + b_n \sin(n\omega_R t)$$

$$\int_0^{T_{OS}} I_{UP}.R \cos(m\omega_R t).\, dt = a_m \int_0^{T_R} \cos^2(m\omega_R t).\, dt$$

$$I_{up}.R \left.\frac{\sin(m\omega_R t)}{m\omega_R}\right|_0^{T_{os}} = \frac{a_m}{2} \int_0^{T_R} 1 - \cos(2m\omega_R t)\, dt$$

$$\frac{I_{up}.R}{m\omega_R} \sin(m.\omega_R.T_{os}) = \frac{a_m}{2} . T_R$$

$$a_m = \frac{2}{T_R} \frac{I_{up}.R}{m\underbrace{\omega_R}_{\frac{2\pi}{T_R}}} \sin\left(m.\frac{2\pi}{T_R}.T_{os}\right)$$

$$a_m = \frac{1}{m\pi} \times I_{up}.R \times \sin(m.\Phi_{os}) \quad \checkmark \Rightarrow a_1 = \frac{I_{up}.R}{\pi} \sin(\Phi_{os})$$

$$I_{up}.R \left.\frac{-\cos(m\omega_R t)}{m\omega_R}\right|_0^{T_{os}} = \frac{b_m}{2} \int_0^{T_R} 1 + \cos(2m\omega_R t) . dt$$

$$\frac{I_{up} \cdot R}{m\omega_R}\left[1-\cos\left(m\omega_R T_{os}\right)\right] = \frac{b_m}{2} \cdot T_R$$

$$b_m = \frac{1}{m\pi} I_{up} \cdot R \left[1-\cos\left(m\omega_R T_{os}\right)\right]$$

$$V_{ctrl} = V_{ctrl0} + a_0 + a_1 \cos(\omega_R t)$$

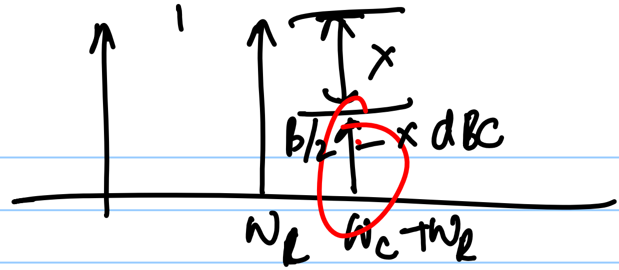
$$f_{vco} = K_{vco}(V_{ctrl0}+a_0) + K_{vco}\, a_1 \cos(\omega_R t)$$

$$V_{out} = \sin\Big(\underbrace{2\pi K_{vco}(V_{ctrl0}+a_0)}_{}t + \int 2\pi K_{vco}\, a_1 \cos(\omega_R t)\, dt\Big)$$

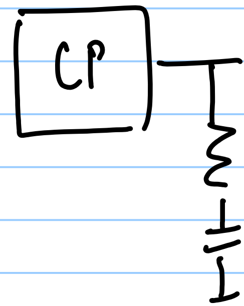
$$= \sin\Big(\omega_0 t - \underbrace{\frac{2\pi K_{vco}\, a_1}{\omega_R}}_{\beta} \sin(\omega_R t)\Big)$$

$$\beta = \frac{2\pi K_{vco}}{\omega_R} a_1 = \frac{2\pi K_{vco}}{\omega_R} \cdot \frac{I_{up} \cdot R}{\pi} \sin(\Phi_{os})$$

$$\text{Ref. Spur} = +20\log_{10}\left(\frac{\cancel{2}K_{vco}\cdot I_{up}\cdot R}{\omega_R\cdot\cancel{\pi}}\sin(\Phi_{os})\right)$$

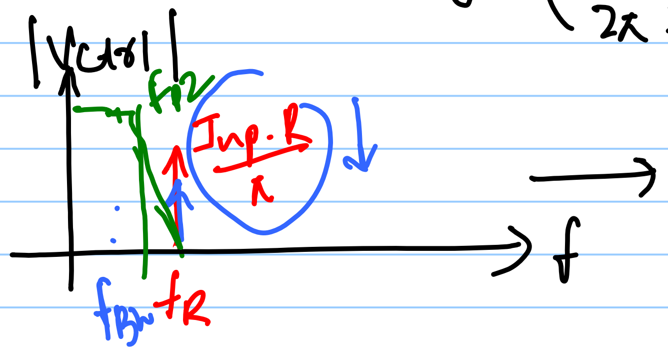


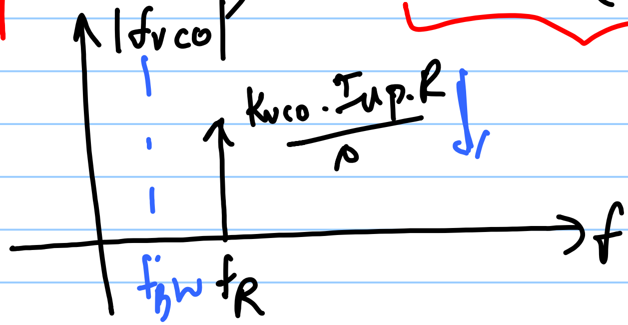
$$20\log_{10}\left(\frac{\text{Mag. of Spur}}{\text{Mag. of carrier}}\right)$$



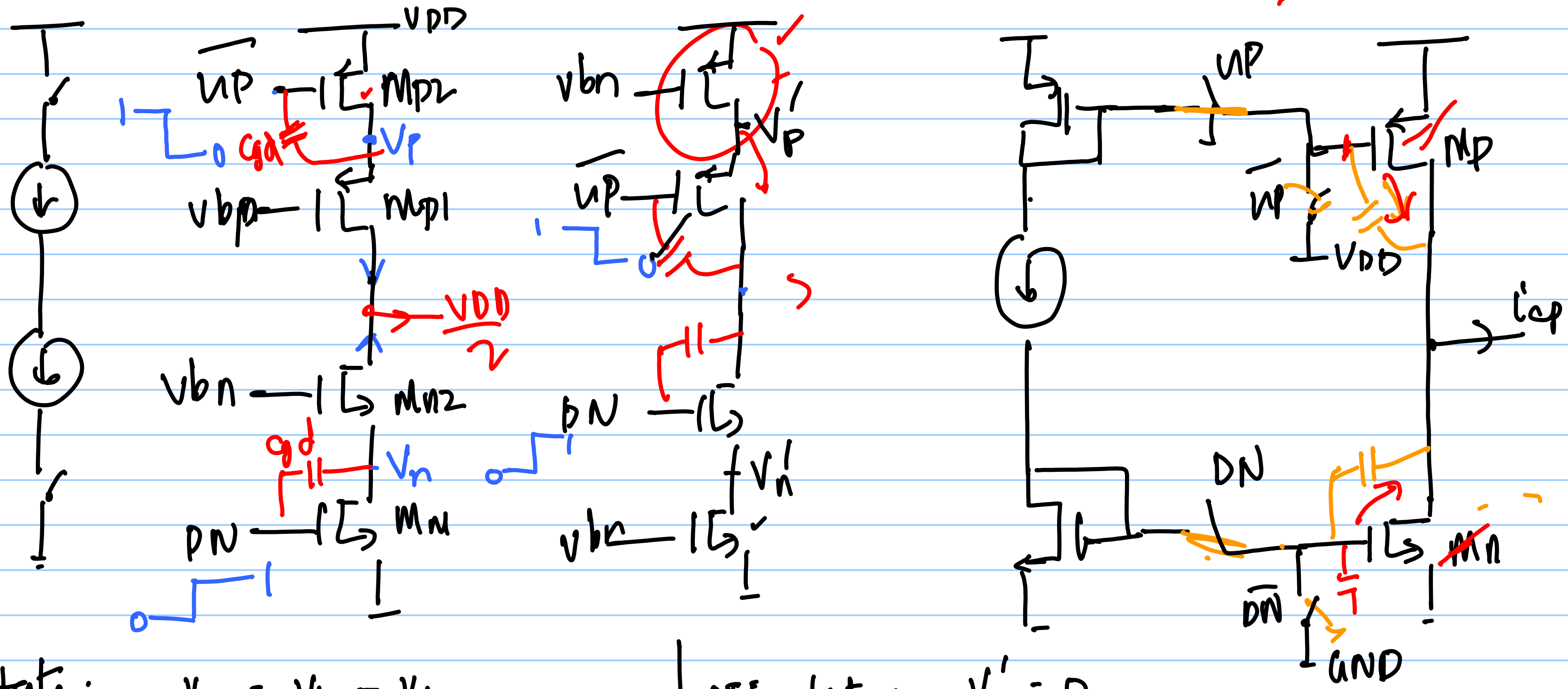
$$= 20\log_{10}\left(\frac{K_{vco}\cdot I_{up}R}{\omega_R}\sin(\Phi_{os})\right)$$

$$= 20\log_{10}\left(\frac{F_{BW}\downarrow}{2\pi F_R\uparrow}\sin(\Phi_{os})\right) + \underbrace{20\log_{10}\left(\frac{F_{P2}\downarrow}{F_R}\right)}$$





Source-switched   Drain-switched



OFF state: $V_n = V_{bn} - V_{tp}$

$V_p = V_{bp} + |V_{tp}|$

ON state: $V_n = 0$

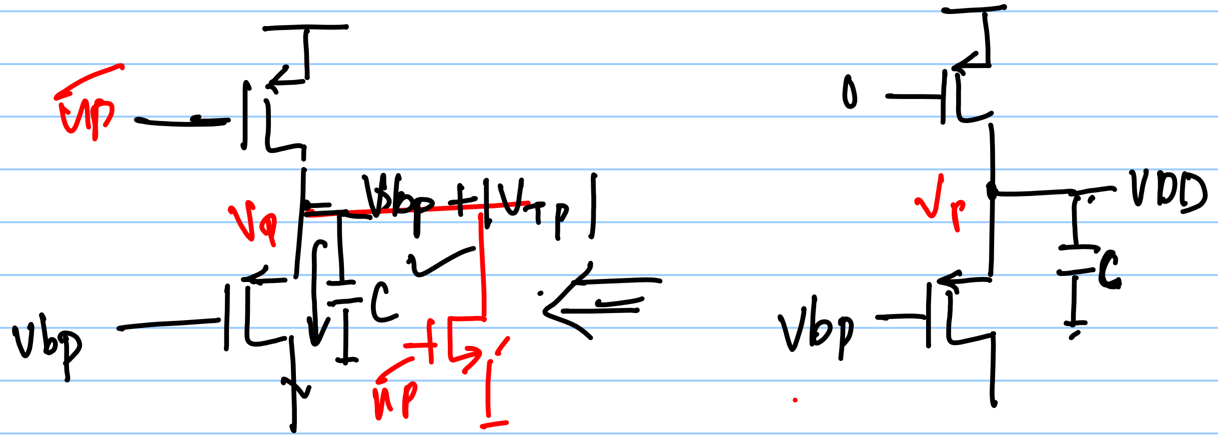
$V_p = V_{DD}$

OFF state: $V_n' = 0$

$V_p' = V_{DD}$

ON state: $V_n' =$

$V_p' =$



$\overline{UP}$
Vq
Vbp + |V_Tp|
Vbp
C
UP
0
Vp
VDD
C
Vbp